REMARKS

Claims 1-32 are pending. Claims 1, 8 and 23 were amended to clarify the structure of the SCR. Claims 11-13 and 26 were amended to address the Examiner's claim objections. Withdrawal of the outstanding objections and rejections is respectfully requested for at least the reasons set forth below.

No new matter was added. The amendments to claims 1, 8 and 23 are fully supported by at least paragraph [0133] on page 40 of the present specification, and by original claims 16 and 28.

Claim Objections

Claims 11-13 and 26 were amended correct minor informalities and no new matter was added.

Rejection under 35 U.S.C. § 103(a)

Claims 1-15 and 23-27 were rejected under 35 U.S.C. § 102(e) as being unpatentable over U.S. Patent No. 6,590,261 (Su et al.), hereinafter, "Su" in view of U.S. Patent No. 4,646,124 (Zunino), hereinafter, "Zunino."

Claims 16-22 and 28-32 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Su in view of Zunino and further in view of U.S. Patent No. 6,756,831 (Tong, et al.), hereinafter, "Tong." The Applicants respectfully traverse the rejection for the reasons listed below.

1. Patentability of independent claims 1, 8 and 16

Amended claims 1 and 8, and original claim 16 each recite an SCR having the following specific structure:

<u>Claim 1</u>

(a) a silicon-controlled rectifier (SCR) including:
(i) a first transistor of a first type integrally formed with the SCR including a first gate, and
(ii) a second transistor of a second type integrally formed with the SCR including a second gate

<u>Claim 8</u>

(a) a silicon-controlled rectifier (SCR) including:
(i) a p-type transistor formed integrally with the SCR, and
(ii) an n-type transistor formed integrally with the SCR

<u>Claim 16</u>

a plurality of silicon-controlled rectifiers (SCR), each of the SCRs including a p-type transistor and an n-type transistor integrally formed with the SCR

Regarding claim 1, the Examiner admits that the transistor limitations are not disclosed in Fig. 4 of Su. Accordingly, the Examiner relies on Zunino to provide the transistor limitations. The Examiner asserts at the bottom of page 5 of the Office Action that it would have been obvious to replace Su's MLSCR 230 and MOS transistor 220 with Zunino's PNPN transistor which the Examiner characterizes as being an <u>SCR</u> (page 5, lines 9-10). Applicant respectfully disagrees with this modification of Su for at least the following reasons:

1. Contrary to the Examiner's statement on page 5, lines 8-11 of the Office Action, The parasitic PNPN transistor referred to in Zunino does not form an SCR. Nor does Zunino's level shifting BIMOS integrated circuit form an SCR.

Column 3, line 59-63 of Zunino discloses a parasitic PNPN transistor but does not disclose or suggest that this parasitic PNPN transistor forms an SCR. <u>**Although SCR's are PNPN devices, not all PNPN devices are SCR's.**</u> See the Appendix which describes four layer diodes in general, and four layer diodes which are used as SCR's. Four layer diodes which are used as SCR's must be triggered by a <u>gate</u>. No such gate is disclosed or suggested in Zunino.

Column 1, line 65 to column 2, line 2 of Zunino discloses forming a level shifting BIMOS integrated circuit on a p-type substrate having a n-type epitaxial layer grown on the face of the p-type substrate and having electrical components formed in the n-type epitaxial layer, which include a pair of complementary pair of MOS transistors and at least one bipolar

transistor. However, Zunino does not disclose or suggest that the complementary pair of MOS transistors (16 and 34) form an SCR. Column 2, lines 42-44 and Fig. 1 of Zunino discloses a side sectional view of a complementary pair of low power logic MOS transistors 16 and 34 formed in a portion of an integrated circuit. Column 2, lines 49-56 and Fig. 3 of Zunino disclose a low power logic circuit employing the complementary MOS transistors 16 and 34 for driving a high power NPN transistor that may be formed in the integrated circuit of Figs. 1 and 2. The complementary MOS transistors 16 and 34 do not form an SCR. Moreover, column 4, line 60 to column 5, line 6 and Fig. 3 of Zunino further discloses that the complementary MOS transistors 16 and 34 operate at a ground reference level and provide a logic output signal that is connected to an input of a pull-up switch and a pull-down switch.

It is improper to replace transistor elements with dissimilar transistor elements unless there a suggestion for doing so. Since Zunino has no disclosure of forming SCR's, Zunino cannot provide the necessary suggestion to replace Su's MLSCR 230 and/or Su's MOS transistor 220 with Zunino's PNPN transistor.

2. Zunino has nothing whatsoever to do with ESD protection, and thus even if Zunino disclosed or suggested an SCR (which it does not), there is no motivation to replace Su's MLSCR 230 and MOS transistor 220 with Zunino's PNPN transistor. The Examiner's rationale for the replacement is that "[t]he elimination of transistor 220 is done for the purpose of reducing the cost of the circuit as the need to purchase discrete MOS transistors is eliminated" (page 6, lines 7-9). This is an improper motivation. First, a MOS transistor is not equivalent in function to Zunino's parasitic PNPN transistor. Second, the Examiner does not point to any evidence that there would be a cost reduction.

It is also unclear from the Examiner's rejection as to exactly what element(s) in Su are being replaced. The Examiner states that it would have been obvious to replace Su's MLSCR 230 and MOS transistor 220 with Zunino's PNPN transistor. However, it is unclear if the Examiner is asserting that (i) <u>both</u> the MLSCR 230 <u>and</u> the MOS transistor 220 would be replaced with only one of Zunino's PNPN transistor, (ii) <u>each</u> of the MLSCR 230 <u>and</u> the MOS transistor 220 would be replaced with one of Zunino's PNPN transistor, thereby providing two PNPN transistors. However, regardless of which replacement is presumed, Zunino's failure to

disclose or suggest an SCR or a circuit related to ESD protection renders such a replacement as being improper.

Regarding claims 8 and 16, the Examiner's relies upon the same reasoning as claim 1 in asserting that Su's SCR can be replaced by Zunino's SCR to provide the claimed structure highlighted above. However, this reasoning is incorrect for the same reasons as described above regarding claim 1. Nor does Tong make up for the above-noted deficiencies in Su and Zunino.

For at least the reasons set forth above, claims 1, 8 and 16 are believed to be patentable over the applied combination of references.

2. Patentability of independent claims 23 and 28

Amended claim 23 and original claim 28 each recite the following steps related to an SCR:

> Claim 23
> providing a silicon-controlled rectifier (SCR) having a holding voltage, the SCR including:
> (i) a first transistor of a first type integrally formed with the SCR including a first gate;
> (ii) a second transistor of a second type integrally formed with the SCR including a second gate
>
> Claim 28
> providing a plurality of silicon-controlled rectifiers (SCR), each of the SCRs including a p-type transistor and an n-type transistor formed integrally with the SCR

In the outstanding Office Action, the Examiner's relies upon the same reasoning as claim 1 in asserting that Su's SCR can be replaced by Zunino's SCR to provide the claimed structure highlighted above. However, this reasoning is incorrect for the same reasons as described above regarding claim 1.

For at least the reasons set forth above, claims 23 and 28 are believed to be patentable over the applied combination of references.

3. Patentability of dependent claims

The rejected dependent claims are believed to be patentable because they depend from allowable independent claims and because they recite additional patentable features.

Conclusion

Insofar as the Examiner's rejections were fully addressed, the instant application including claims 1-32 is in condition for allowance. A Notice of Allowability of all pending claims is therefore earnestly solicited.

Respectfully submitted,

Zi-Ping Chen, *et al.*

April 3, 2006 By: Clark Jablon

(Date)

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Enclosure: Appendix (4 pages)

7549154 v2

APPENDIX
(Application No. 10/726,490
Reply to Office Action of December 2, 2005)

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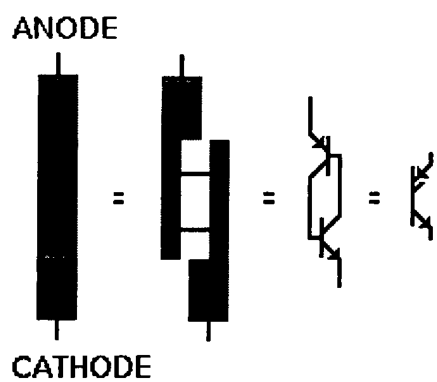
The Four-Layer Diode

If we add a junction to a transistor, we get a four-layer device. At first glance, this may seem either useless or counter-productive, but this is not the case.

The diagram to the right shows the structure and nomenclature of the four-layer diode, together with its equivalent structure, showing its logical behavior and its schematic symbol. Rather than acting simply as an odd sort of diode, this device actually behaves as two transistors, interconnected back-to-back as shown. The external connections are designated the *cathode* (n-type connection) and *anode* (p-type connection). This keeps us from having to distinguish between the n-emitter and the p-emitter.



In operation, the device is placed in a circuit so that the anode is held positive with respect to the cathode. If this voltage polarity is reversed, the four-layer diode exhibits two reverse-biased junctions and will not conduct current.

The applied voltage appears mainly across the reverse-biased center junction of the device, and the quiescent current flowing through the device is quite small, consisting essentially of a leakage current. As the applied voltage increases slowly, the leakage curent increases slowly

as well, until the applied voltage reaches a certain level. At this voltage, known as the *breakover voltage* or *firing voltage* of the device, the two logical transistors both turn on and current increases dramatically. At the same time, the voltage across the diode decreases to almost zero, and the applied voltage now appears across whatever load circuit or device is connected in series with the diode. The diode has just switched from its off (or *blocking*) state to its on state.

Once the four-layer diode is conducting, it will continue to conduct as long as current continues to flow. It can only be turned off by reducing the circuit voltage and/or current to below the levels required to sustain conduction. Typically, this means either removing power totally from the circuit, or else using the diode as a device to periodically discharge a capacitor.

The breakover voltage and current-handling capacity of a given four-layer diode are determined by the exact details of its manufacture. Four-layer diodes may be manufactured with a wide range of voltage and current ratings.

There is one problem which can appear with the four-layer diode: if the applied voltage rises rapidly, the inherent capacitance associated with the reverse-biased middle junction will transmit the applied voltage more directly, and cause the diode to switch on at a voltage well below its designed breakover voltage. This phenomenon is known as the *rate effect*.

Applications for the four-layer diode fall into two categories. In active cirucits, they can be used as the active element in a sawtooth waveform generator or triggered pulse generator. Or, they can be used as a "crowbar" element in a power supply. In this last application, the four-layer diode is placed directly across the output terminals of the power supply, used to power delicate circuitry. If the supply voltage should rise for any reason to a level that might damage the circuitry, the four-layer diode breaks over and draws a heavy current from the supply. This overloads the supply and causes the fuse or circuit breaker to blow. It's a drastic measure, but still much better than allowing expensive circuit components to be damaged or destroyed.

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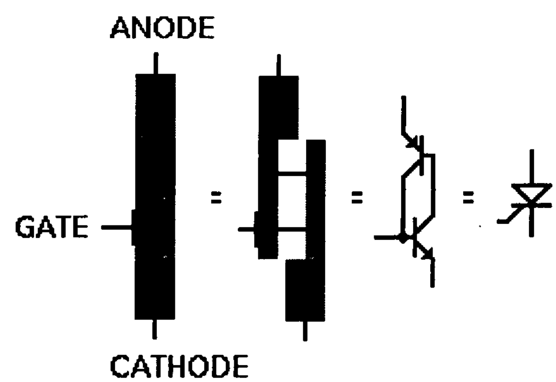
The Silicon Controlled Rectifier

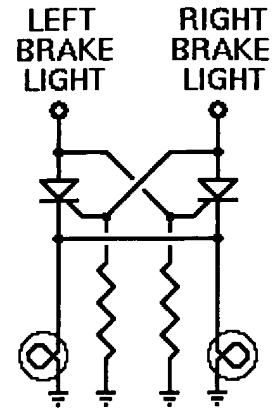
The basic four-layer diode has a number of useful properties and capabilities, but would become even more useful if it could be more accurately controlled. To do this, however, we must gain access to more than just the outer ends of the device.

The four-layer construction shown to the right is known as a *Silicon Controlled Rectifier*, or SCR. To form it, we have added a connection to the p-type region next to the cathode. This connection is known as the *gate*.



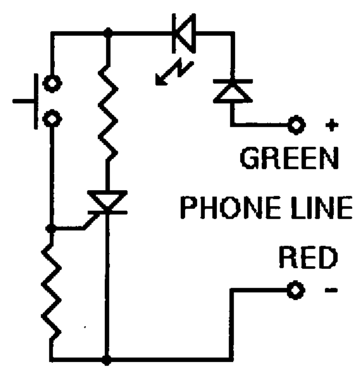
If we ground both the cathode and the gate, and apply a positive voltage to the anode, no current will flow through this device. This is in keeping with the basic four-layer diode. In this case, however, we will not allow the applied anode voltage to exceed the SCR breakover voltage. Thus, if nothing happens, the SCR will remain turned off indefinitely.

However, if we now apply a small positive voltage to the gate lead sufficiently to forward bias the cathode junction, the device will immediately turn fully on. Again, this is in keeping with the behavior of the basic four-layer diode. The difference is that we can accurately control the timing and the applied gate voltage, if necessary. Thus, we can determine the conditions under which the SCR will fire more accurately than we can for the basic four-layer diode.



A modern application for the SCR is the "cyclops" brake light on all cars now sold in the USA. This circuit, as shown in the schematic diagram to the right, uses two SCRs cross-connected with each other (each gate connected to the other SCR's anode) and triggered from the regular brake lights on either side of the rear of the vehicle. The lights are connected to the two cathodes, which are connected together so that either SCR can keep both lights on once they are triggered. If only one SCR is triggered (as when you use a turn signal), the triggered SCR gets no anode voltage from the opposite brake light, so the "cyclops" light remains off. Only if both brake lights are on together will the "cyclops" turn on. Once it does, it remains on regardless of turn signals as long as the brake is applied. When you release the brake, power is removed from the "cyclops" as well as from the brake lights and they all turn off.

The two resistors have a relatively high resistance, and are not critical in any case. They ensure that the gates of the two SCRs are held off while the brake lights are unpowered. The resulting circuit is simple and inexpensive, yet quite robust and easily able to handle the bumps and jolts of an automotive environment.



Another practical application is in a telephone "hold" circuit. Triggering the SCR causes the circuit to contiuously draw current through the telephone wires, thus causing the switching station to assume a phone is still in use. You must hang up the phone while still pressing the button in order to ensure that the SCR remains triggered. Picking up the same or another receiver in the house reduces the current through the SCR enough that it turns off.

You can use multiple copies of this circuit. However, only the LED on the active "hold" circuit will light up. Also, pressing the button while no phone is in use will engage that "hold" circuit at once, so it should be used with care. And of course you should check with your local phone company before connecting anything to the phone line. This is to protect your circuitry as much as to protect the phone company from improper and possibly damaging connections.
